Nanostructured Catalysts for Fuel Cells
The University of Alabama and Alabama A&M University

John Wiest
Alabama DOE EPSCoR
P.O. Box 870203
Tuscaloosa, AL 35487-0203
Phone: 205/348-1727
Fax: 205/348-7558
jwiest@coe.eng.ua.edu

Recognizing the ubiquitous and critical role of catalysis in fuel cell technology, we are investigating nanostructured catalysts for use in the anode, cathode and fuel processor. Although the unusual catalytic chemistry of very small (~1 nm) metal particles is now recognized, we are exploiting the less appreciated role of metal-support interaction on stability and reactivity to develop novel catalysts for these applications. The specific catalysts that we l examine consist of metal nanoparticles anchored to carbon and oxide supports. The former is used for electrodes (membrane or traditional carbon mesh) and the latter for fuel processing catalysts. Our approach to the work consists of an integrated sequence: 1) synthesis of metal alloy nanoparticles by novel chemical reduction methods; 2) fabrication of model catalysts by vapor deposition and edge decorated photolithography; 3) characterization of the model and real catalysts by a variety of techniques including spectroscopy and atom probe field ion microscopy; and 4) simulation of the nanoparticles and their interaction with reacting molecules and the support by a combination of classical molecular dynamics and transition state Monte Carlo techniques. The ultimate goal of the work is discovery of stable, effective catalysts that substantially reduce or replace the noble metals traditionally required in fuel cell systems.

The program builds on the basic materials research in fuel cell technology conducted during the first three years of the project, including improvements to the polymer electrolyte membrane, bipolar and end plates, anode and cathode electrocatalysts, and fuel processing catalysts. Specific advances include: 1) preparation of novel, highly fluorinated, proton conducting polymers for membranes with reduced fuel crossover and higher temperature operation; 2) fabrication of new bipolar plates, including metal foams with low permeability giving rise to a more uniform distribution of local current density; 3) inclusion of catalytic nanoparticles in the membrane surface by dendrimer-assisted deposition to improve proton transport; and 4) preparation of catalysts with true metal nanoparticles (~1 nm) anchored to an oxide surface by metal-support interaction.